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Solitary precaval right renal artery: A cadaveric case report and review

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ABSTRACT

This study reports an extremely rare morphology and branching pattern of the right renal artery. During our routine dissection of a 52-year-old male body cadaver, we observed that the right kidney was receiving a single main renal artery, which passed anterior to the inferior vena cava (Perceval); the artery also, has a unique origin (the abdominal aorta). We think comprehensive knowledge of renal vascular abnormalities will enhance the proper interpretation of radiological images and enable safer interventions such as retroperitoneal surgical and urological procedures. Familiarity with the renal vascular anomalies would also be of particular importance during endovascular embolization, stent placement procedures, and surgical treatment of aortic aneurysms and reno-vascular hypertension treatment.

Keywords: Single Precaval, Renal artery, Kidney, Precaval

1. INTRODUCTION

The renal arteries are large, and paired arteries typically arise from the lateral side of the abdominal aorta at the level of the second lumbar vertebra at the same level of the superior mesenteric artery (Raheem et al., 2008), or below the superior mesenteric artery at the level of L1/L2 intervertebral disc (Leslie and Sajjad, 2020). The right renal artery is usually lower than the left one. It passes dorsal to inferior vena cava (IVC) and the right renal vein to reach the right kidney's hilum (Kumar et al., 2014). The main renal arteries are approximately 4–6 cm long and 5–6 mm wide. The precaval right renal artery (PRRA) is a tubular structure that arises from the aorta or common iliac artery, passes ventral to IVC and terminates in the right kidney (Srivastava et al., 2013). The PRRA, according to the literature, could be single, aberrant or accessory renal artery (Krishnaveni and Kulkarni, 2013). Accessory renal arteries (ARA) can arise anywhere from the aorta often below the main renal artery and enter the kidney through the hilum. In contrast, the aberrant or polar renal arteries enter the kidney through the capsule outside the hilum (Leslie and Sajjad,

2020). We followed Graves nomenclature in this report, using the term "single precaval right renal artery" (Graves, 1956).

The incidence of renal vasculature variations is approximately 25% of the population. On the other hand, PRRA is rare and occur in about 0.8% of the population (Petit et al., 1997). Table 1 demonstrates the prevalence and findings of the PRRA using different diagnostic modalities. The presence of the PRRA could be associated with other renal anomalies such as bifid renal pelvis, malrotated, enlarged or ectopic kidney (Radolinski et al., 2006). The presence of PRRA might also be associated with ureteric obstruction with or without other clinical symptoms or signs, like flank pain, hematuria and or hypertension (Yeh et al., 2004). The data showed that around 5% of the patients with hydronephrosis had PRRA, mostly as an accessory artery supplying the right lower pole (Yun et al., 2007; Gupta et al., 2011).

Variations of abdominal aorta are common (Alsharif et al., 2016). Awareness of the arteries that arise from the anterior aspect of the aorta reduces the chance of their injury or misidentification during laparoscopy or other invasive procedures (Famurewa et al., 2018). Although a respective variation of renal arteries has been reported (Table 1), the present case exhibits a single PRRA with a remarkable site and level of origin without any other associated renal anomalies. We also observed a difference in the course of the artery, which is a rare phenomenon with few reported precedents (Radolinski et al., 2006; Babu, 2014; Bouali et al., 2012; Srivastava et al., 2013). Sound knowledge of the potential variant and anomalies in renal vascularisation pattern is essential and must be taken into consideration by anatomists, urologists, vascular surgeons, and interventional radiologists.

Table 1 Shows the prevalence of the single PRRA

Authors	Total number of cases studied	Modality of study	Prevalence of Single PRRA "%."	Notes
(Holden et al., 2005)	100	Live donors	1%	with a low precaval course
	186 (retrospective)	Spiral CT	0.5%	-
(Yeh et al., 2004)	39 all have precaval right renal artery (prospective)	Spiral CT	2.5%	no other clinical symptoms or signs, including flank pain or haematuria, were considered attributable to the precaval artery
(Gupta et al., 2011)	50	Cadaveric dissection	2%	Arises from the anterior aspect of aorta 40mm from aortic opening, it gave accessory branch to the lower pole
(Apisarnthanarak et al., 2012)	65	living related renal donors CT angiography	1.5%	-
(Srivastava et al., 2013)	73	The multidetector-row contrast-enhanced computed tomography angiography	1.3%	Arising from anterolateral aspects as seen in the figure

2. CASE REPORT

During a routine undergraduate gross session of anatomy in the abdominal region of a 52-year-old male body cadaver (177 cm in length and 73 kg weight), at the Faculty of Medicine, Prince Sattam Bin Abdulaziz University in 2019. It was noted that the right kidney receives a single renal artery, which passes ventral to inferior vena cava. Furthermore, the renal artery had an extraordinary

origin; it arises from the ventral aspect of the abdominal aorta rather than its lateral side. Moreover, it emerges between celiac and superior mesenteric arteries at the level of the intervertebral disc between T12 and L1 vertebrae (Fig-1).

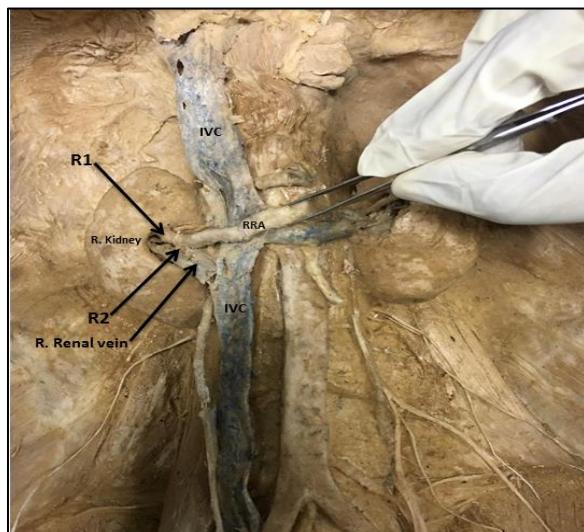


Figure 1 shows the presence of single renal artery (RRA), which passes ventral to inferior vena cava(IVC). It emerges between celiac and superior mesenteric arteries. The bifurcation occurs at the hilum into the upper and lower segments

The artery also shows unique morphological features and parameters: the distance between its origin and the point of bifurcation of the abdominal aorta is approximately 130 mm, and the distance between the site of origin and the right kidney is about 46 mm (Fig-2).

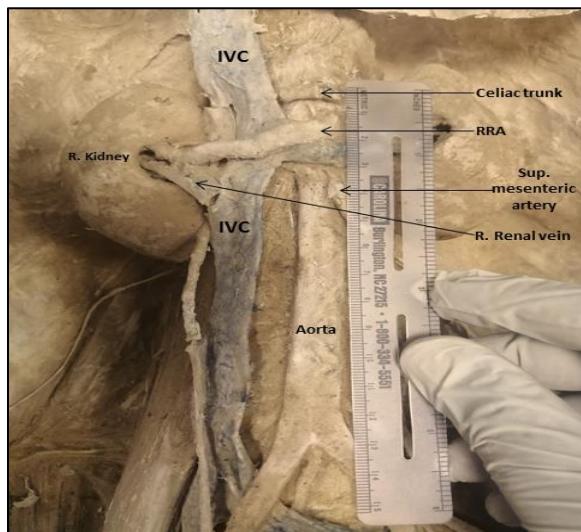


Figure 2 shows the morphological features and parameters: the distance between its origin and the point of bifurcation of the abdominal aorta is approximately 130 mm, and the distance between the site of origin and the right kidney is about 46 mm.

By tracking the artery, we observed that it arises from the aorta at about 30 degrees as a single branch, then passes toward the hilum of the right kidney in regular anatomic order “vein, artery, renal pelvis”. The bifurcation occurs at the hilum into the upper and lower segments (Fig-1). The present case shows the normal position and topography of the right kidney without any other associated renal anomalies.

3. DISCUSSION

The arterial supply of the kidney has a wide range of variations that illustrate the nature and complexity of its development and how vascularization changes in embryonic and early fetal life. In the 8th week of the prenatal life, concurrently with the

development of the kidneys, a group of arteries arise from the lateral side of the abdominal aorta. The dorsal group of these arteries later gives the lumbar arteries (Radolinski et al., 2006), while the ventral ones give the mesonephric arteries (Srivastava et al., 2013). The middle part of these mesonephric arteries develops into renal vessels (Srivastava et al., 2013). With the kidneys migration, it gets its supply by successive mesonephric arteries, and with its ascend, a new group of arteries form while the lower ones degenerate. Upon reaching its final position, only one remains "renal artery" (Srivastava et al., 2013). Many studies suggested that the PRRA develops as a result of a persistent renal vessel from the ventral portion of the abdominal aorta after the formation of the inferior vena cava (Meng et al., 2002), but before gonadal vein descent (Srivastava et al., 2013, Radolinski et al., 2006). The literature also concluded that its occurrence during the 8th week of development, and that is due to the repositioning and rotation of the entire renal unit (Meng et al., 2002). Comprehensive renal vascular variation knowledge will enhance the proper interpretation of radiological images and enable safer interventions such as retroperitoneal surgical and urological procedures.

The PRRA is described as either an accessory aberrant or single renal artery (Yeh et al., 2004, Bouali et al., 2012) as we noticed the latter in the current case. The literature stated that the presence of PRRA could be associated with some renal anomalies, such as the anterior rotation of the lower pole of the right kidney (Yeh et al., 2004). Anomalies of the renal artery were also highly correlated with the co-occurrence of other venous system variations, particularly in males (Sośnik and Sośnik, 2019). It is worth noting that no associated anomalies were recognized in the present case. Knowledge of the potential variants and anomalies in the kidney and their vascularisation pattern is crucial as it can lead to serious medical consequences. Although most of these variants are discovered accidentally by different imaging methods, they can still have significant clinical effects on the kidneys during laparoscopy or surgical interventions or at routine cadaver dissection.

The presence of PRRA linked to the development of ureteropelvic junction (UPJ) obstruction mainly on the right side (Yeh et al., 2004). The ureter usually begins in the hilum of the kidney posterior to the renal vein and artery at the UPJ; a site of clinical significance for stenosis and renal stones lodging (Lescay et al., 2020). Identification of PRRA that crosses anterior to the IVC is important when planning surgical interventions. It contributes to the safety and success of both open and minimally invasive renal surgery. PRRA might be confused with other vessels like the inferior, superior mesenteric, or even aberrant hepatic arteries particularly during retroperitoneal approaches when only the right gonadal vein is expected to lie in the precaval area, and the artery might be injured accidentally (Corey et al., 2005). In addition, it is essential to identify crossing vessels in radiologic imaging science it may be a source of massive bleeding during the endopyelotomy. In contrast, the presence of such vessels reduces the success rate of endopyelotomy from 83% to 33% (Yeh et al., 2004), it may also increase the morbidity rate during surgical placing of an inferior vena cava filter (Deshpande et al., 2014). The renal arteries are considered end arteries; so ligation may lead to an infarction in the corresponding renal parenchyma (Raheem et al., 2008).

Careful renal vasculature assessment is important before the minimally invasive urologic procedures, like endopyelotomy and before other laparoscopic radical and donor nephrectomy to prevent vessels damage and bleeding. PRRA facilitates the process of laparoscopic donor nephrectomy (Radolinski et al., 2006). It is mandatory to maximize the length of both renal vessels by taking them at their insertion/origin, during donor nephrectomy to achieve successful anastomosis. Careful dissection is usually performed for the renal artery to its origin at the aorta with the kidney in a "flipped" position to get the maximum optimal length of the renal artery. The presence of the renal artery anterior to the IVC facilitates the dissection (without the need to flip the kidney), which allows for successful efficacious right laparoscopic donor nephrectomy (Radolinski et al., 2006).

4. CONCLUSION

To our knowledge, the incidence of single PRRA variations have already been reported in the literature, but its occurrence as an individual variation without any malformations is exceedingly rare. A deeper knowledge of the embryogenesis and the probable congenital anomalies can be of great help in minimizing unexpected injuries and avoiding much difficulty that might be encountered. The renal anomalies could be complex, and the choice of detailed preoperative investigations is recommended for proper evaluation. Awareness of the clinical, surgical importance is the key to preventing any unforeseen complications.

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Competing interest

The authors declare that there are no conflicts of interests.

Authors' contribution

All authors contributed equally in the literature search, interpretation of the articles and review of the manuscript. All the authors have read and approved the final version of the manuscript.

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Data and materials availability

All data associated with this study are present in the paper.

Conflict of interest

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